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Alkenone-based Records of Miocene pCO_2 Revisited

Pratigya J. Polissar, Lamont Assistant Research Professor, Lamont-Doherty Earth Observatory
In collaboration with **Timothy J. Bralower**, Professor of Geosciences, The Pennsylvania State University.

Abstract

The concentration of atmospheric carbon dioxide and other greenhouse gases are thought to be primary controls on Cenozoic climate. Warm Paleocene and Eocene climates were accompanied by high atmospheric CO_2 concentrations while the present "ice house" climate has much lower CO_2 concentrations. Furthermore, decreasing atmospheric CO_2 concentrations during the late Eocene may have crossed a threshold that set the stage for the glaciation of Antarctica at the Eocene-Oligocene boundary. This long-term correspondence of Cenozoic CO_2 concentrations and global climate suggests that greenhouse gases are a fundamental modulator of global temperatures. In this context the reconstructed levels of Miocene pCO_2 are puzzling. Boron isotope values of planktonic foraminifera and carbon isotopes values of alkenone molecules both suggest pCO_2 values were low—perhaps even lower than today—yet global temperatures were significantly warmer than at present. This is especially true of the late Miocene, when new sea-surface temperature records indicate much warmer temperatures yet reconstructed pCO_2 values are less than 280 ppm. While this discrepancy could reflect different climatic boundary conditions compared to today, it is also possible that proxy errors are systematically underestimating the true pCO_2 levels, as is suggested by higher pCO_2 values reconstructed from leaf stomata. The alkenone-based pCO_2 values for the late Miocene are based upon a single site and have not been replicated elsewhere. Furthermore, a fundamental assumption in alkenone pCO_2 reconstructions to date has been that cell geometry and algal growth rates remain constant. The goal of this proposal is to generate a new dataset of alkenone-based pCO_2 estimates for the late Miocene from several ODP sites that attempt to constrain cell geometry and growth rate changes to test whether late Miocene pCO_2 values were indeed as low as previously reconstructed.